

ACOUSTIC IMAGING SYSTEM ARCHITECTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a nonprovisional patent application of U.S. Provisional Patent Application No. 62/207,589, filed Aug. 20, 2015 and titled “Acoustic Imaging System Architecture,” the disclosure of which is hereby incorporated herein by reference in its entirety.

FIELD

[0002] This disclosure relates generally to imaging systems, and more particularly, to systems and methods for operating an acoustic imaging system as a biometric sensor associated with a display of an electronic device.

BACKGROUND

[0003] An electronic device can include a biometric sensor, such as a fingerprint sensor, to establish an identity of an unknown user prior to performing a task. The fingerprint sensor obtains an image of a fingerprint of the user and compares information derived from that image to information stored in a protected database accessible to the electronic device. The task is performed by the electronic device only after the comparison results in an affirmative match.

[0004] A conventional fingerprint sensor includes an array of capacitive sensors positioned below a dielectric material that may be touched by a user. The resolution of the fingerprint sensor is bounded, among other things, by the number of capacitive sensors within the array, the physical size of each capacitive sensor, and the integration time required to sample each capacitive sensor. In addition, capacitive sensors are typically optically opaque; it may be difficult to incorporate a conventional fingerprint sensor into a display of an electronic device.

SUMMARY

[0005] Embodiments described herein reference an acoustic imaging sensor incorporating a distribution of transducers disposed to circumscribe a portion of a substrate. In one example, the substrate is a transparent cover of a display an electronic device formed from glass, sapphire, or another optically transparent material. In this example, the distribution of transducers may be hidden by a bezel of the display.

[0006] In one example, each transducer is operated in one or more modes, such as a drive mode and a sense mode. When in the drive mode, a transducer mechanically deforms in response to a drive signal. When in the sense mode, a transducer produces an electrical signal in response to a mechanical deformation. A transducer is mechanically deformed as a result of a mechanical wave such as a surface wave, shear wave, plane wave, or other acoustic wave type that propagates through a top surface and/or through the thickness of the substrate.

[0007] The acoustic imaging sensor also includes a controller configured to generate an ultrasonic wave within, or on a top surface of, the substrate and, separately, to receive acoustic reflections resulting therefrom. An acoustic reflection is generated by an acoustic impedance mismatch resulting from an object engaging the top surface of the substrate. In one example, the object engaging the top surface of the substrate is user's finger.

[0008] The controller generates an ultrasonic wave by generating and applying a drive signal to one or more of the transducers, operating these elements in the drive mode. Thereafter, the controller operates at least one of the transducers in the sense mode to receive one or more electrical signals generated by the transducers.

[0009] The acoustic imaging sensor also includes an image resolver configured to, based on the one or more electrical signals received by the controller, construct an image, either partial or complete, of an object (if any) engaging the top surface of the substrate.

[0010] In one embodiment, the transducers are disposed as rows adjacent the perimeter of the circumscribed portion of the substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Reference will now be made to representative embodiments illustrated in the accompanying figures. It should be understood that the following descriptions are not intended to limit the disclosure to one preferred embodiment. To the contrary, each is intended to cover alternatives, modifications, and equivalents as may be included within the spirit and scope of the described embodiments as defined by the appended claims.

[0012] FIG. 1 depicts an example electronic device that can include an acoustic imaging system within a display.

[0013] FIG. 2 depicts a simplified block diagram of an acoustic imaging system.

[0014] FIG. 3A depicts a distribution of transducers associated with an acoustic imaging system disposed on a bottom surface of a cover so as to circumscribe a substantially rectangular area.

[0015] FIG. 3B depicts another distribution of transducers associated with an acoustic imaging system disposed on a bottom surface of a cover so as to circumscribe a substantially rectangular area.

[0016] FIG. 4A depicts a simplified cross-section of a portion of an acoustic imaging system.

[0017] FIG. 4B depicts a simplified cross-section of a portion of another acoustic imaging system.

[0018] FIG. 4C depicts a simplified cross-section of a portion of yet another acoustic imaging system.

[0019] FIG. 4D depicts a simplified cross-section of a portion of yet another acoustic imaging system.

[0020] FIG. 4E depicts a simplified cross-section of a portion of yet another acoustic imaging system.

[0021] FIG. 4F depicts a simplified cross-section of a portion of yet another acoustic imaging system.

[0022] FIG. 5A depicts a simplified cross-section of a portion of an acoustic imaging system that may be configured for capacitive signaling, drive, and/or sense.

[0023] FIG. 5B depicts a simplified cross-section of a portion of another acoustic imaging system that may be configured for capacitive signaling, drive, and/or sense.

[0024] FIG. 6A depicts an acoustic imaging system implemented with a distributed controller.

[0025] FIG. 6B depicts a simplified cross-section of a portion of an acoustic imaging system implemented with a distributed controller.

[0026] FIG. 7 depicts example operations of a method of operating an acoustic imaging system.

[0027] The use of the same or similar reference numerals in different drawings indicates similar, related, or identical items where appropriate.